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METHODS TO REDUCE THE OCCURRENCE OF FALSE ALARMS USING VOICE RECOGNITION TECHNOLOGY

CHANG-BAE NOH[1] & WONSHIK NA[2]

[1]*Department of Electronic and Radio Engineering, Kyung-Hee University Yongin, Republic of Korea*

[2]*Department of Computer Science, Namseoul University Cheonan, Republic of Korea*

ABSTRACT

Background/Objectives

Early detection is of paramount importance in the prevention of massive fire outbreaks, as are analyzing the nature of the fires.

Methods/Statistical Analysis

Fire alarms play a key role in extinguishing fires. The system proposed in this study utilizes sensors and speech recognition to directly or indirectly detect fires in a step-by-step manner. Data from the sensors are compiled into a fire data that is wirelessly shared thereby allowing an earlier extinguishment, while image processing is used to reduce the frequency of false alarms.

Findings

The invention of fire alarms has greatly contributed to reducing fire damage. However in recent years the difference in owning an alarm and not have become minimal. The system proposed in this study overcomes the physical limits of existing isolated alarm systems by using wireless connection and speech recognition technology to supplement the shortcomings of sensors and allowing era-time transmission of information about the fire. Furthermore, when signs of a fire are detected the fire alarm films images and videos that provide an insight into the situation. Through this a fire alarm system is created that increases the speed and accuracy of fires being extinguished.

Application/Improvements

A systematic fire alarm system can increase the speed at which a fire is observed and action is taken. It can also provide the foundation upon which another disaster system can be created.

KEYWORDS: Voice Recognition, Image Processing, Detection System, False Alarm & Smart Phones

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Original Article

INTRODUCTION

The objective of fire alarms is to rapidly inform people when a fire breaks out. However, in 2014 in Seoul alone there were 156 instances of fire alarms sounding false alarms. Also, 14.6% of fire alarms set up in 15 apartment complexes over two decades old were found to malfunction. This reduces the credibility of fire alarms, causing unease and/or a false sense of security in users.[1, 2] The system proposed in this paper includes multiple methods to detect anomalies by utilizing sensors that can check variables in the environment such as temperature, flames, and smoke. It also takes blind spots into consideration and supports a manual mode triggered by the users'

voice. Image processing technology is also incorporated into the system to increase the credibility of the fire alarm. In case of a fire, the user's smart phones are notified with a push message that includes the first frame of the video filmed by the built-in camera, giving visual proof to users outside the affected site. The system helps ensure a rapid awareness and action in case of a fire.[3]

PROCESSING METHODS FOR VOICE RECOGNITION SIGNALS

Since its introduction in the 1950s, voice recognition technology has been the subject of continuous research in Korea. Voice recognition technology has the advantage of allowing speakers to quickly enter their information while on the move or working. (Figure 1)

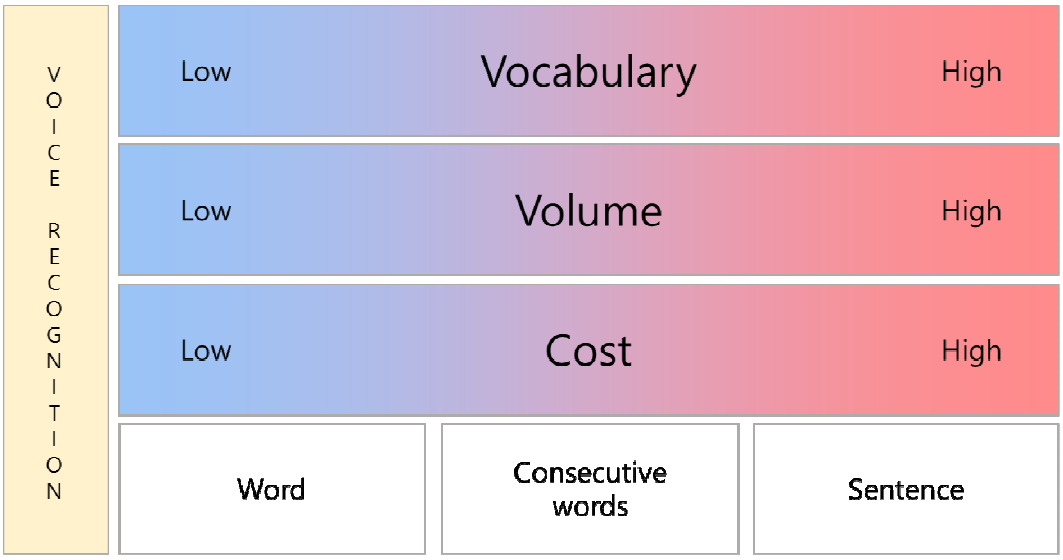

Figure 1: Voice Recognition Technology Features

It can also be used in areas such as security authentication by utilizing the voice signals unique to each speaker. As such examples show, voice recognition technology can be highly convenient. However, this technology remains at an unsophisticated level due to difficulties such a lowered recognition rates from background noise, varying recognition rates depending on the speaker's vocal characteristics, and the size limit of the vocabulary DB. To increase the recognition rate of the received vocal signals, an extraction process that isolates the relevant data and removes background noise from it is necessary. The optimization technology depends on what area the voice recognition technology is being utilized.

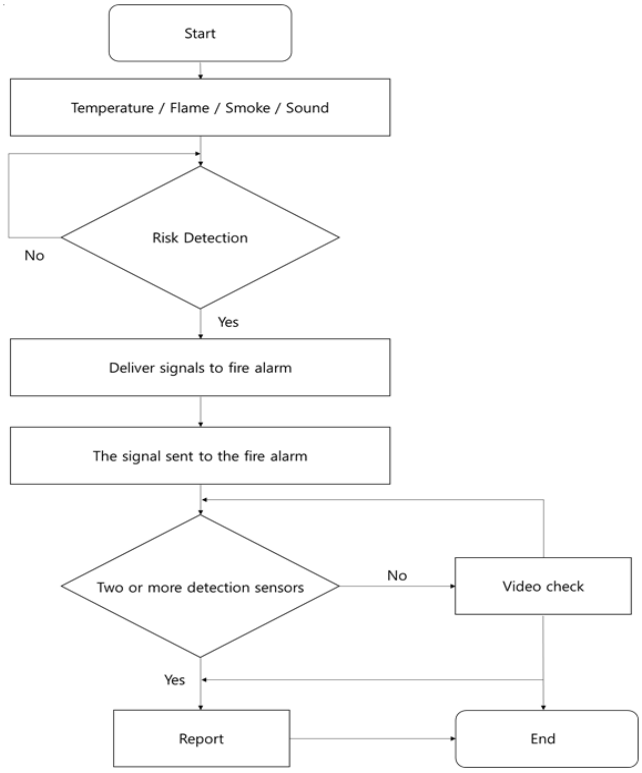

Figure 2: Flowchart

For the proposed system, the 'fixed word recognition' method that recognizes only specific words is the most suitable, however it is time consuming and expensive as a vocal model needs to be developed based on the recordings and analyses of many speakers' vocal data. Thus, a 'speaker dependent recognition' is proposed instead, which is relatively simple to implement. Here, the fire alarm user is required to register a single phrase, "help, fire!", and that is the only speech signal recognized. (Figure 2)

PROPOSED SYSTEM

The fire alarm system proposed in this study utilizes sensor information to determine the possibility of a fire. The collected data is transferred to the server, which forwards it to multiple users' smart phones via wi-fi thereby leading to swift action being taken in the early stages of the fire. Also, voice recognition and image processing technologies are combined to allow users to remotely analyze the situation, which reduces the issue of false alarms. In case of emergency, the pre-registered location information further contributes to swift reportage of and action against the fire.[4] (Figure 3)

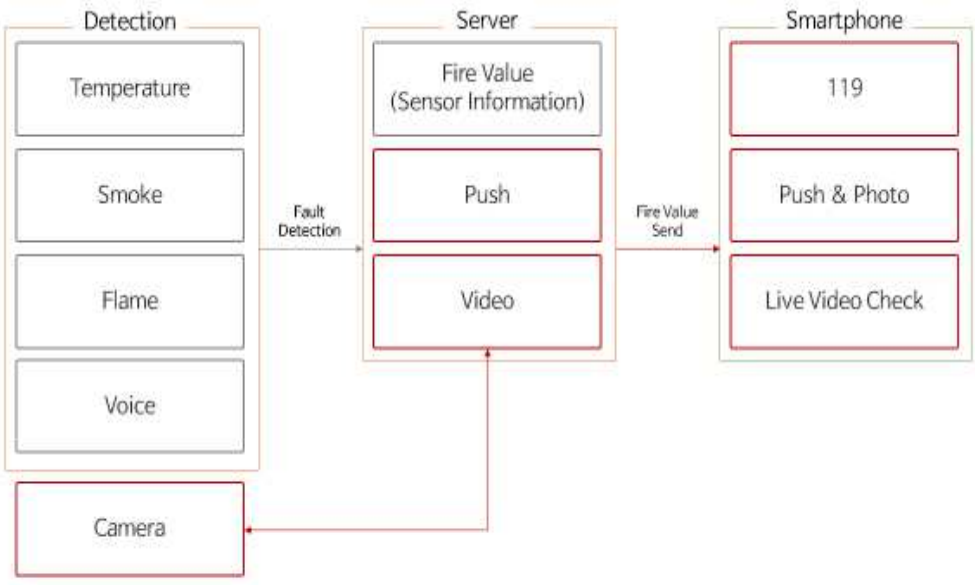

Figure 3: Structure Map of the Proposed System

Fire Detection

The proposed fire alarm is equipped with built-in sensors for temperature, flames, and smoke for direct detection of fire, as well as a voice recognition module that aids indirect detection. Multiple detection methods are utilized to form a systematic overview of the emergency that is relayed to users outside the affected area.[5] In case the fire breaks out in a blind spot outside the sensors' detection zone or in areas blocked by walls or other structures, voice recognition can be used to recognize an emergency. A fire is detected when the sensors receive data input that is above the figures set for its environment. Four direct and indirect fire detection methods are used, and fires are classified into one of 16 categories and designated a danger level ranging from safe, caution, warning, and danger. (Figure 4)

Fire awareness				Fire Data	Division	Fire awareness				Fire Data	Division
Temperature	Flame	Smoke	Voice			Temperature	Flame	Smoke	Voice		
X	X	X	X	0000	Safety	O	X	X	X	1000	Caution
X	X	X	O	0001	Caution	O	X	X	O	1001	Warning
X	X	O	X	0010	Caution	O	X	O	X	1010	Warning
X	X	O	O	0011	Warning	O	X	O	O	1011	Danger
X	O	X	X	0100	Caution	O	O	X	X	1100	Warning
X	O	X	O	0101	Warning	O	O	X	O	1101	Danger
X	O	O	X	0110	Warning	O	O	O	X	1110	Danger
X	O	O	O	0111	Danger	O	O	O	O	1111	Danger

Figure 4: Fire Data Categorization

Managing Program

The proposed system allows users to receive an alert when they are near the fire alarm, or on their phones when away. The system periodically transfers the sensor data to the servers over wi-fi. Users can receive push messages on their smart phones when there is a change to the data sent to the server.

Push Notifications

The push message function is activated when there is a change in the data.[6] The message is composed of a text overview of the emergency informing users of the type and number of sensors detecting the fire. Also included is the first frame of the video filmed by the fire alarm to aid users outside the affected area to grasp the severity of the situation and/or the possibility of a false alarm.

Registering Fire Alarms

Users need to register their fire alarm in the system to receive push messages on their smart phones. The product serial number can be used to register each alarm. Users can also designate names to allow for easy distinguishing between alarms. Location information can be set to allow easier tracking of the fire outbreak.[7] Pre-installed fire alarms can also be registered and used to send push notifications by registering the home address, product key, and name of the alarm in the system. The system allows for multiple fire alarms to be registered, and alarms can be managed as a whole or individually when deleting or changing alarm settings. (Figure 5)

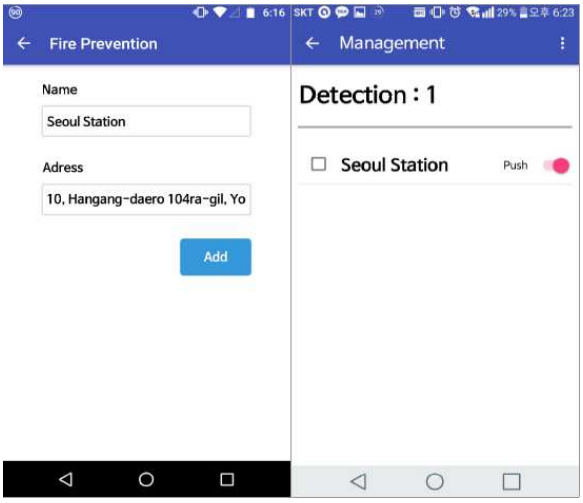

Figure 5: Fire Alarm Registration and Management

DETECTING ANOMALIES VIA VOICE RECOGNITION TECHNOLOGY SYSTEM MODEL

In the early stages of a fire when the fire alarm's sensor has not yet detected the anomaly, or if the fire is in the alarm's blind spot, voice recognition technology is used so that quick action can be taken and people notified of the situation. The fire alarm's built-in voice recognition module continuously remotely detects voices and manually determines the emergency when a specific phrase such as "help, fire!" is said by the user in case of a fire. (Figure 6) (Figure 7)

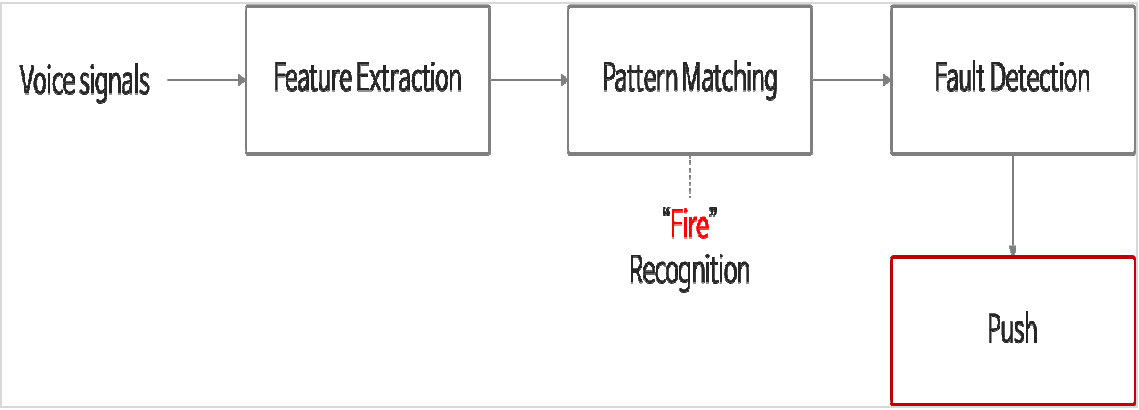

Figure 6: Flow Chart of Fire Detection using Voice Recognition

Classification	Characteristic	Contents
Technical form	Speaker dependent	Target only specific pre-registered speakers. Excellent recognition
Pronunciation form	Isolating Language	Isolated word recognition
Number of words	Small capacity	Hundred words or less

Figure 7: Characteristics of the Proposed System's Voice Recognition Technology

It is inevitable that voice recognition is hindered by background noise and noise distortion. Also, the SNR signal amplification degradation issue is one that cannot be fixed by simply increasing the volume, since the issue is not just with a low volume but the increase of the dynamic range of the input signal.[8] In order to improve the recognition rate, it is necessary to extract the optimized voice by removing noise.[9] The voice recognition technology proposed in this system recognizes a specific phrase "help, fire!" through pattern matching. The speaker dependent function of the speaker recognition technology is used to render the user's voice free of noise. As with fire detection sensors, when an anomaly is detected via voice recognition the camera starts filming a video to alert the user of the emergency and forwards the first frame to the user's smart phone with a push notification. The message allows users to run the application on their smart phone to view the video in real time, report to 119, or turn off the alarm. This way the alarm can also be turned on manually in blind spots, allowing swift action to be taken in case of a fire.

REMOTE MANAGEMENT AND REACTION VIA IMAGE PROCESSING

Image processing technology has been added to the existing fire alarm systems in order to minimize problems from malfunctioning and false alarms. The built-in camera in the alarms automatically turns on and starts filming when the sensors detect an anomaly. The camera stops filming when the user has checked the situation, the fire has been put out, or if the user turns off the alarm. This function allows users to quickly discern real and false alarms, even when they are not at the place of emergency. (Figure 8) (Figure 9)

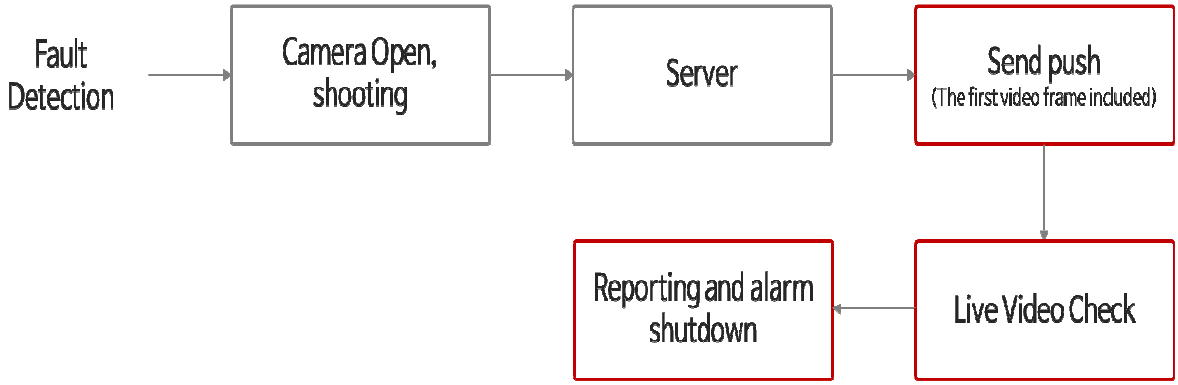

Figure 8: Image Processing Flow Chart in Case of Anomaly Detection

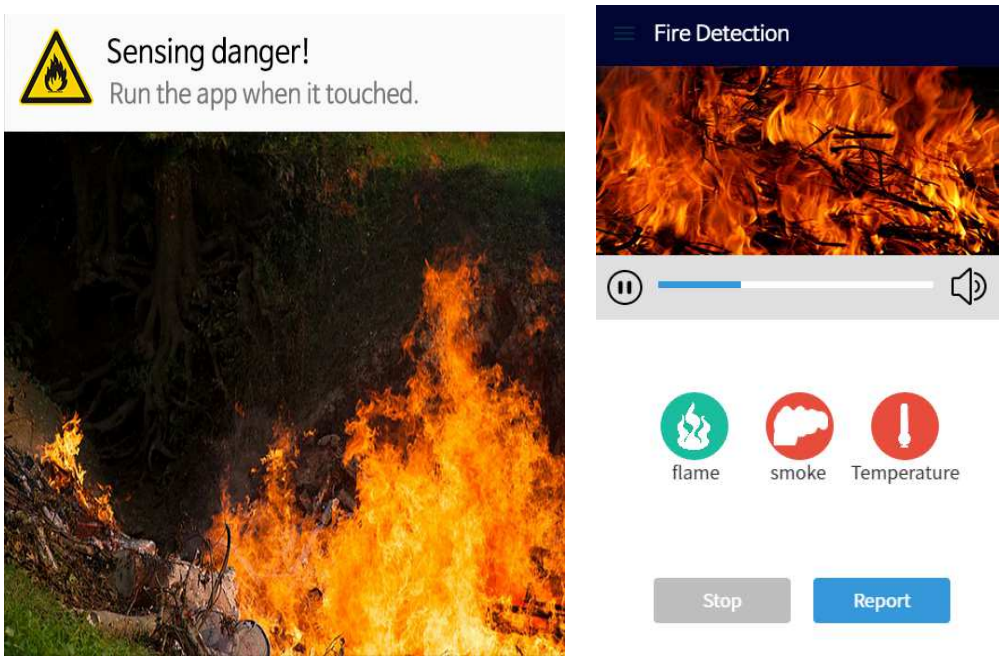

Figure 9: Push Messaging and Live Video Feed in Case of Anomaly Detection

To reduce the risk of personal information being leaked, video information can only be accessed by the first registered user of the alarm. A frame is extracted the moment the camera starts filming and forwarded as an attachment in the push message. Users can tap on the push message and get a real time feed of the video of the affected site and take action. The video data will be saved in the server for a determined amount of time, and the user can use management tools to view the data. (Figure 10)

Figure 10: Coping after Sensing Danger

CONCLUSIONS

The fire system in this study solves the problem of malfunctioning or false alarms in fire alarm systems by utilizing sensors to detect anomalies, automatically turning on the built-in camera to film a video as proof of the emergency, and forwarding it to users with a push message. Furthermore, it gives the users the ability to manually trigger the alarm through voice recognition in case a fire breaks out in a blind spot outside the detection range of the sensors that measure the surrounding environment itself. However, current voice recognition technology is not at a highly effective state as variables such as the placement of the alarm, the user, geographic characteristics etc. can all influence the recognition rate.[10] To overcome this issue, continued research in the technology for increasing the recognition rate of specific phrases and reducing background noise is necessary. Through this, a credible fire alarm system can be built that solves the problem of fires spreading due to safety frigidity caused by faulty alarms, and awareness for fire safety among users can be improved.

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REFERENCES

1. *VISUAL DIVE, "Fire Safety ignorance" http://www.visualdive.com/2016/04/%EC%8B%9C%EB%81%84%EB%9F%AC%EC%9A%B0%EB%8B%88-%EA%B2%BD%EB%B3%B4%EA%B8%B0-%EC%A2%80-%EA%BA%BC%EC%A3%BC%EC%84%B8%EC%9A%94%ED%99%94%EC%9E%AC%EA%B0%90%EC%A7%80%EA%B8%B0/, 2016.*
2. *S. S. Lee, A Study on Improvement of the Smoke Detector for Unwanted alarm in Korea, Mokwon University Graduate School of Media Industry Information, 2015, p. 55-56.*
3. *J. J. Lee, Fire Recognition System based on Network Camera, Journal of Korean Society for Imaging Science and Technology, Vol 13, No. 4, 2007, p. 233-242.*
4. *Y. M. Yu, Study on the Development Plan of the ubiquitous 119-based reporting system, Kyonggi University erection, industry Graduate school Fire fighting City Disaster Major, 2009.*
5. *H. K. Kim, A tendency of Development for Wireless Fire Detection System And Research of Technical Standard, Fire Technology Research, 2009, p. 28-41.*
6. *J. K. Lee, D. K. Kim, Y. K. Kim, Implementation of wireless fire alarm monitoring system using 802.11g protocol, Fire Safety*

Journal, 2005, p. 266-271.

7. *J. J. Jung, A. R. Hong, C. W. Lee, B. S. Son, Developing Wireless Fire Detector with Remote Inspection Function for Apartment Housing, J. Korean Soc. Hazard Mitig, Vol. 14, No. 6, 2014, p. 267~272.*
8. *S. J. Oh, Speech enhancement in noisy environments for distant-talking speech recognition, Korea University Radio Communications Engineering Computer Science Major Dissertations, 2012, p. 29-33.*
9. *Y. G. Jin, W. H. Lim, Y. J. Kim, Analysis of the acoustic signal for long-distance speech recognition performance ensuring process side, The Magazine of the IEIE, 16-24, 2010, p. 9.*
10. *Y. P. Kim, H. Y. Lee, A Study on Improved Method of Voice Recognition Rate, The Journal of the Korea Institute of Electronic Communication Sciences, Vol. 8, No. 1, 2013, p. 77-83.*